Building with artificial atoms: Emergent properties in multi-component nanocrystal superlattices

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Abstract:

The synthesis of colloidal nanocrystals (NCs) with controlled crystal shape, structure and surface passivation provides ideal building blocks for the assembly of new thin films and devices. The NCs are "artificial atoms" with tunable electronic, magnetic, and optical properties. This talk will briefly outline what is possible in the assembly and integration of NC superlattices focusing on the properties that emerge in single component superlattices that retain and enhance many of the desirable mesoscopic properties of individual NCs. I show how these novel building blocks can be integrated in to a range of electronic, magnetic and optical devices and highlight exciting opportunities for modeling and simulation to enhance material and device design. Theoretical insight is critically needed in the design space for new materials and devices expands dramatically with the creation binary and ternary NC superlattices (BNSLs & TNSLs). I will give specific examples of we organize differently sized CdSe, CdTe, PbS, PbSe, PbTe, $CuInSe_2$, FePt, $CoPt_3$, Fe_3O_4, $CoFe_2O_4$, Au, Ag, Pd, Pt, PtMn,and NaYF4:Re (Re=rare earths) nanocrystals among other systems into a rich array of multi-functional nanocomposites (metamaterials) exploiting a novel method to direct superlattice formation by interfacial assembly and transfer and show how assembly conditions can be pushed far from equilibrium resulting in oscillatory deposition of solid films with periodicity on both the nano and micro scales.